Reconstructing Syn-Rift, Sag, and Salt Paleogeography, and the Role of Syn-Rift Dynamic Elevation and Dissipation, Gulf of Mexico

James Pindell[1] and Teunis Heyn[2]

[1]Tectonic Analysis Ltd., Duncton, U.K., and Rice University, Houston, Texas
[2]Consultant, Houston, Texas

Abstract

Understanding the paleogeography of the Gulf of Mexico rift/salt basin remains challenged by questions such as: elevation of the syn-rift surface; origin of seawater for salt; salt accommodation mechanisms; and depth of the depositional surface during sag/salt deposition. We assess 5 themes that collectively provide the integrated framework for understanding this important stage in Gulf of Mexico history: (1) relative and absolute plate kinematics; (2) age and occurrence of circum–Gulf of Mexico redbeds and salt; (3) tectono-magmatic features and geometries of syn-rift, top rift, sag, salt, and continent–ocean transitions in seismic data; (4) expression of syn-rift dynamic topography at present-day magma-rich rift analogues; and (5) synrift and early post-rift igneous occurrence maps across the Gulf of Mexico. A 6th “theme” is the similar syn-rift, sag, and salt story for the São Paulo Plateau, whose setting displays an additional crucial observation. Integrating these assessments shows that magma-rich rifting in reconstructed Gulf of Mexico margins began amidst widespread CAMP magmatism, probably with positive dynamic elevation according to analogues. However, North America began its nortwestward flight from Gondwana in Early and Middle Jurassic, providing geographic space for primary rifting and margin extension. By the time of conjugate margin breakup, most of the GoM had moved off the residual Demerara Rise–Guinea Plateau–Bahamas hotspot (Middle Jurassic). We contend that the syn-rift basin’s departure off the dynamically elevated hotspot is recorded by rapid post-kinematic sag and salt deposition, whose accommodation was due to dissipation of dynamic elevation (dynamic subsidence) complementing the basin’s fastest period of thermal subsidence (early post-rift). This dynamo-thermal subsidence occurs as young margins move off hotspots (e.g., Gulf of Mexico, São Paulo Plateau, U.S. Carolinas, Nova Scotia). Summing dynamic and thermal subsidences produces accommodation fast enough to explain thick, short-lived sag–salt sections deposited near global sea level, without also invoking tectonic subsidence except in outer marginal troughs. Depictions of deep air-filled pre-salt holes may be a misleading prediction of purely isostatic models.